## REMARKS

In the Office Action of September 7, 2005, the indicated allowability of claims 7-15 was withdrawn and these claims were rejected under 35 U.S.C. 103(a) as unpatentable over Smart (U.S. Patent No. 6,735,255) in view of IEEE std. 802.11a – 1999: Part II: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications High-Speed Physical Layer in the 5 GHz Band. The claims were also objected to because of informalities in independent claims 7, 8, 13 and 15.

Claims 7, 8, 12, 13 and 15 have been revised. New claims 22-24 have been added. The rejection of the claims is respectfully traversed.

Applicant's disclosure is directed to several methods and systems for processing received signals in a multi-carrier communication system. Claims 7-15 and 22-24 are directed to methods for synchronizing a receiver to a transmitter and, in particular, to methods for identifying an integer frequency offset number. Applicant's invention is intended for use in communication systems such as the 5 GHz wireless local area network using orthogonal frequency division multiplexing (OFDM). In this system, OFDM data symbols are 4 μ secs long and comprise 52 sub-carriers spaced at 312.5 KHz.

As described in paragraph 0009 of the application, to decode the data in a received packet, it is necessary to synchronize the receiver with the received packet. To do this, the receiver must determine and correct for any carrier frequency offset imparted to the sub-carriers due to variation in the nominal values of the in-phase and quadrature (I/Q) modulator and up-converter oscillator frequencies in the transmitter and in the down converter and I/Q de-modulator oscillator frequencies in the receiver. The receiver must also determine the start time of the first OFDM data symbol and correct for any amplitude and phase shift imparted to the sub-carriers during transmission. The 20 MHz sampling clock at the receiver must also be synchronized with the 20 MHz sampling clock at the transmitter. As



1-NY/2010797.1

emphasized in paragraph 0009, the preamble and pilot sub-carriers of the data packet are provided for these synchronization processes. However, the IEEE 802.11 standard does not specify how they are to be used.

At the outset, it should be noted that there are two major types of errors that have to be corrected for. One is an error in the sub-carrier frequency as described at the beginning of the preceding paragraph. This error results in a carrier frequency offset that is typically expressed as the product of a decimal number and the frequency difference between the sub-carriers such as 1.6 x 312.5 KHz. As will be apparent, in this example the decimal number has an integer value of 1 and a fractional value of 0.6. The other error is the sampling error which is the difference between the onset of the data symbol and the opening of the sampling window. This error may be caused by a variety of factors. It results in a sampling offset and the sampling offset may be further broken down into its contributing factors.

The claims of the present invention are directed to the determination of the carrier frequency offset and, more particularly, to a novel and efficient method of determining the integer value in the decimal number used to determine this offset.

A preferred embodiment of this aspect of the invention is illustrated in Figs. 6 and 7 and described more particularly at paragraphs 0033-0039. As described in the first sentence of paragraph 0035, sample values are first frequency shifted by the fine fractional frequency estimate 610 so that any residual frequency offset will be an integer multiple of the sub-carrier frequency spacing. Two long sync symbols in the corrected sample value are then demodulated and combined. If the integer value in the frequency offset is zero, the demodulated long sync symbols will have 53 modulated sub-carriers that correspond to the digital frequency numbers -26 through +26. If the integer value in the frequency offset is $p \neq 0$, the demodulated long sync symbols will have 53 modulated sub-carriers that correspond to the digital frequency number -26+p through +26+p.

To determine the value of p, sets of 53 sub-carrier modulation values with different offsets are created. As stated in the last sentence of paragraph 0035, each of these sets is divided by the known BPSK sub-carrier modulation values of long sync symbols to create an estimate of the channel transfer function at that value of p. For the estimate corresponding to the correct value of p, there is a high degree of correlation between adjacent sub-carriers. However, for estimates corresponding to other values of p, there is no correlation because the BPSK sub-carrier modulation values do not correspond to the correct sub-carriers. Accordingly, to detect the estimate associated with the correct value of p, the values at adjacent sub-carriers in each estimate are compared. In the embodiment of the invention described in paragraph 0036, for each estimate the values at even sub-carrier frequencies in the channel transfer function are used to estimate the values at odd sub-carrier frequencies using an appropriate interpolation algorithm. The estimated values so obtained are correlated with the actual set of odd demodulated sub-carriers. The correlation with the highest magnitude is generated by the estimate that is closest to the correct value of p; and the offset p associated with the channel transfer function estimate that generated that correlation is the integer value of the decimal number used to compute the carrier frequency offset. The integer value can then be used to correct the carrier frequency. As will be appreciated by those skilled in the art, other correlation algorithms can be used as well in the practice of the invention.

While Smart also discloses the use of a correlator in a multi-carrier transmission system he uses it to correct for sampling errors not sub-carrier frequency errors. Smart's system as shown in Fig. 4 comprises a receive buffer 422, a correlator 410, a time domain converter FFT 402, and a filter 405 comprising a magnitude filter 404 and a phase filter 406. A pointer register 408 controls the data sent from buffer 422 to FFT converter 402. Col. 9,

lines 28-30. Correlator 410 is used to initialize the pointer register by locating the beginning of a frame. Col. 10, lines 33-40.

Magnitude filter 404 "attempts to correct for magnitude distortion of the received symbols." Col. 8, lines 22-23. Phase filter 406 "corrects for phase distortion associated with sampling frequency offsets." Col. 8, lines 31-32. Sampling offsets are defined at Col. 8, lines 44-45 as "the difference between the optimal sampling instant and the actual sampling instant." The sampling offsets appear to have two components: timing offsets of a constant nature between transmitter and receiver arising when the frequencies are identical but the phases are offset (Col. 8, lines 35-37) and frequency offsets apparently arising when the speed of the receiver sampling frequency is different from the transmitter's sample clock reference (Col. 8, lines 49-50).

The phase filter 406 corrects for increasing offset by updating its coefficients from symbol to symbol. Col. 8, lines 65-67. The amount of phase correction increases from symbol to symbol requiring an increasing phase correction between successive symbol frames. Col. 9, lines 2-4. When a full sample duration has been slipped or gained, clock recovery and control circuit 460, increments or decrements a pointer value in pointer register 408. The value of the pointer controls the data sent to FFT converter 402. Col. 9, lines 7-30.

From the foregoing description it should be apparent that Smart is not directed to the methods claimed in the applicant's claims 7-15 and 22-24. Smart is not correcting for carrier frequency offset and is not processing the received signal to correct first for the fractional part of the decimal value that determines carrier frequency offset and then determine the integer portion of the decimal value. Further, Smart does not teach the use of a correlation step to determine the integer portion of the decimal value. Since each of the independent claims 7, 8, 15 and 23 recite these steps while Smart does not, each of these claims is patentable over Smart.

Dependent claims 9-14 and 22 are patentable for the same reason claim 8 is patentable. Dependent claim 24 is patentable for the same reason claim 7 is patentable.

For the foregoing reasons the claims presently in this application are believed to be patentable and in condition for allowance. Because of the complexity of the inventive technology, it is also believed desirable to comment on several additional remarks of the Examiner. While section 14.3.3 of the 802.110 Standard does disclose a preamble having long training symbols $T_1$ and $T_2$, section 17.3.3 does not disclose how these symbols might be used in any synchronization process. In particular, it does not disclose the use of long training symbols in the processes claimed by applicant.

In addition, with reference to claims 8 and 15, section 17.3.3 does not disclose the extraction of vectors of modulation values of data sub-carriers with progressive trial integer offsets. If the Examiner is referring in his rejection to the vectors of equations (6) and (8) in section 17.3.3, a reading of the text just before these equations reveals that equation (6) is simply the modulation values of the short OFDM training symbol and equation (8) is the modulation values of the long OFDM training sequence. There are no integer offsets in these values and no suggestion of the extraction of vectors of modulation values with progressive trial integer offsets.

With reference to claims 9 and 15, sections 17.3.2.1 and 17.3.3 do not disclose dividing each vector by long sync symbol modulation values to obtain the channel transfer function. The word divide in use in sub-clauses (h), (i) and (j) of section 17.3.2.1 in the sense of separate into groups and not in the sense of mathematical division. And division is not mentioned in section 17.3.3.

With reference to claims 10 and 11, it is respectfully submitted that the 802.11a Standard also does not disclose estimating odd frequency values.

With reference to claims 12-15, Smart does not disclose the correlation of interpolated odd frequency values.

In view of the foregoing, it is submitted that there is no basis for the rejection of the claims on Smart in view of the 802.11a Standard.

In view of the foregoing, Applicants believe that all of the pending claims are now in condition for allowance and respectfully request the Examiner to pass the subject application to issue. If for any reason the Examiner believes any of the claims are not in condition for allowance, he is encouraged to phone the undersigned at (212) 309-6632 so that any remaining issues may be resolved.

Respectfully submitted,

Date: March 6, 2006

Francis E. Morris

Francis E. Morris
Reg. No. 24,615
MORGAN, LEWIS & BOCKIUS LLP
(212) 309-6632
Customer No. 009629



1-NY/2010797.1